NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

Technical Program Review

March 15-16, 2016

LLNL-PRES-684817

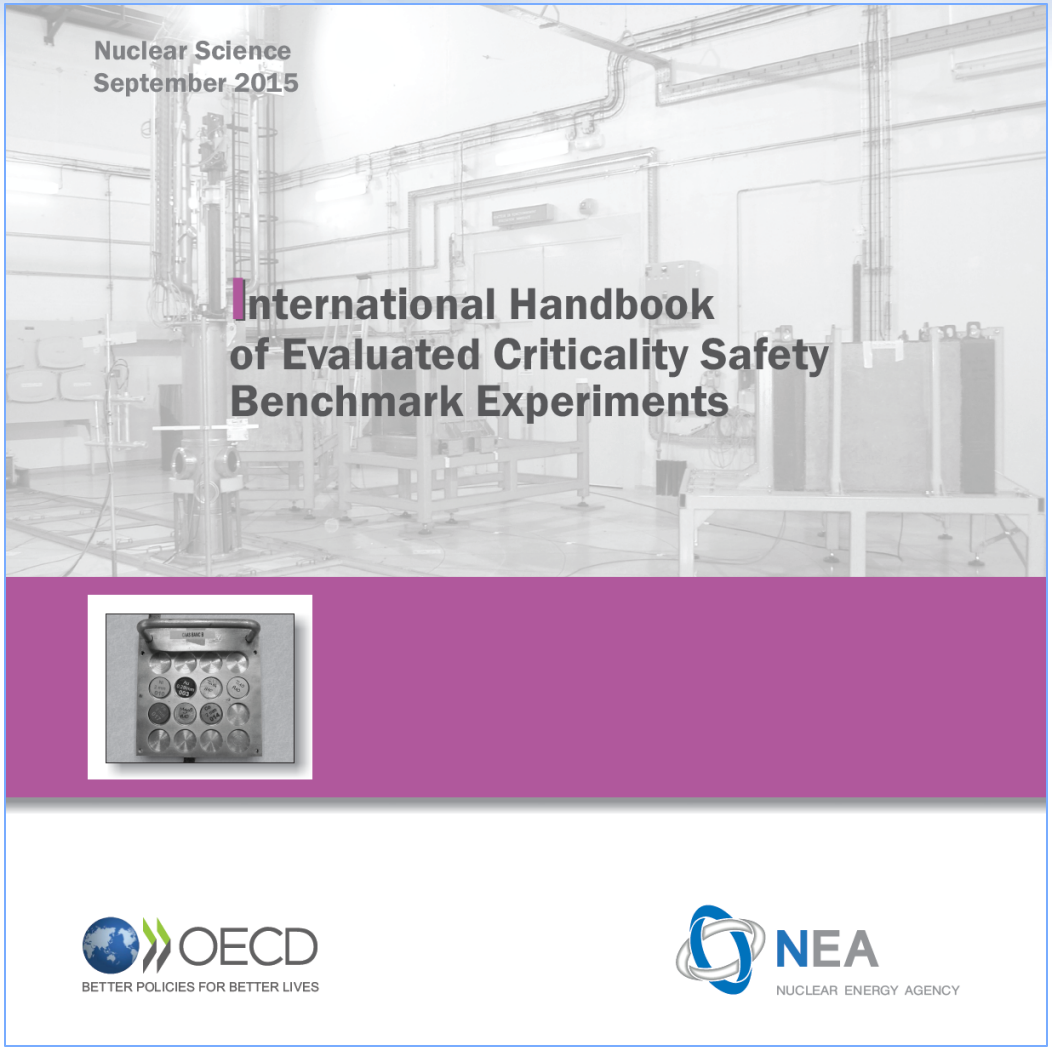
ICSBEP Accomplishments

Dave Heinrichs
Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory, P.O. Box 808, L-198, Livermore, CA 94551-0808
This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

Outline

- FY-2015 accomplishments
- FY-2016 accomplishments
- FY-2016 work in progress
- NEA liaison activities
- Upcoming meetings
- Issues



FY2015 Accomplishments – NCSP

NEA/NSC/DOC(95)03/IV
Volume IV

LEU-COMP-THERM-096

NEW

PARTIALLY-REFLECTED WATER-MODERATED SQUARE-PITCHED $U(6.90)O_2$ FUEL ROD LATTICES WITH 0.67 FUEL TO WATER VOLUME RATIO (0.800 CM PITCH)

Evaluator

Gary A. Harms
Sandia National Laboratories

Internal Reviewer
John A. Miller

Independent Reviewer

Nicolas Leclaire
Institut de Radioprotection et de Sûreté Nucléaire (IRSN)

SNL	NCSP IE and T&EP Activities at Sandia	Gary Harms

NEA/NSC/DOC(95)03/VIII
Volume VIII

ALARM-TRAN-AIR-SHIELD-001

NEW

NEUTRON ACTIVATION FOIL AND THERMOLUMINESCENT DOSIMETER RESPONSES TO A BARE PULSE OF THE CEA VALDUC SILENE CRITICAL ASSEMBLY

Evaluators

Thomas M. Miller
Cihangir Celik
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Internal Reviewer

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Independent Reviewers

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Sylvain Beytout (External Contractor, MILLENNIUM)
Institut de Radioprotection et de Sûreté Nucléaire

ORNL	The Collaborative International Benchmark Evaluation for the SILENE Solution Critical Experiment	Thomas Miller

FY2015 Accomplishments – TRG

NEW

NEA/NSC/DOC(95)03/III
Volume III

IEU-SOL-THERM-005

UNREFLECTED CRITICAL DIMENSION OF AQUEOUS SOLUTION OF U(37 %)O_2F_2 IN SPHERICAL GEOMETRY

Evaluators

Tanja Kaiba
Gašper Žerovnik
Luka Snoj
Igor Lengar

Jožef Stefan Institute

Internal Reviewer
Igor Lengar

Independent Reviewer

Margaret A. Marshall
Idaho National Laboratory

Institut "Jožef Stefan"

INL Idaho National Laboratory

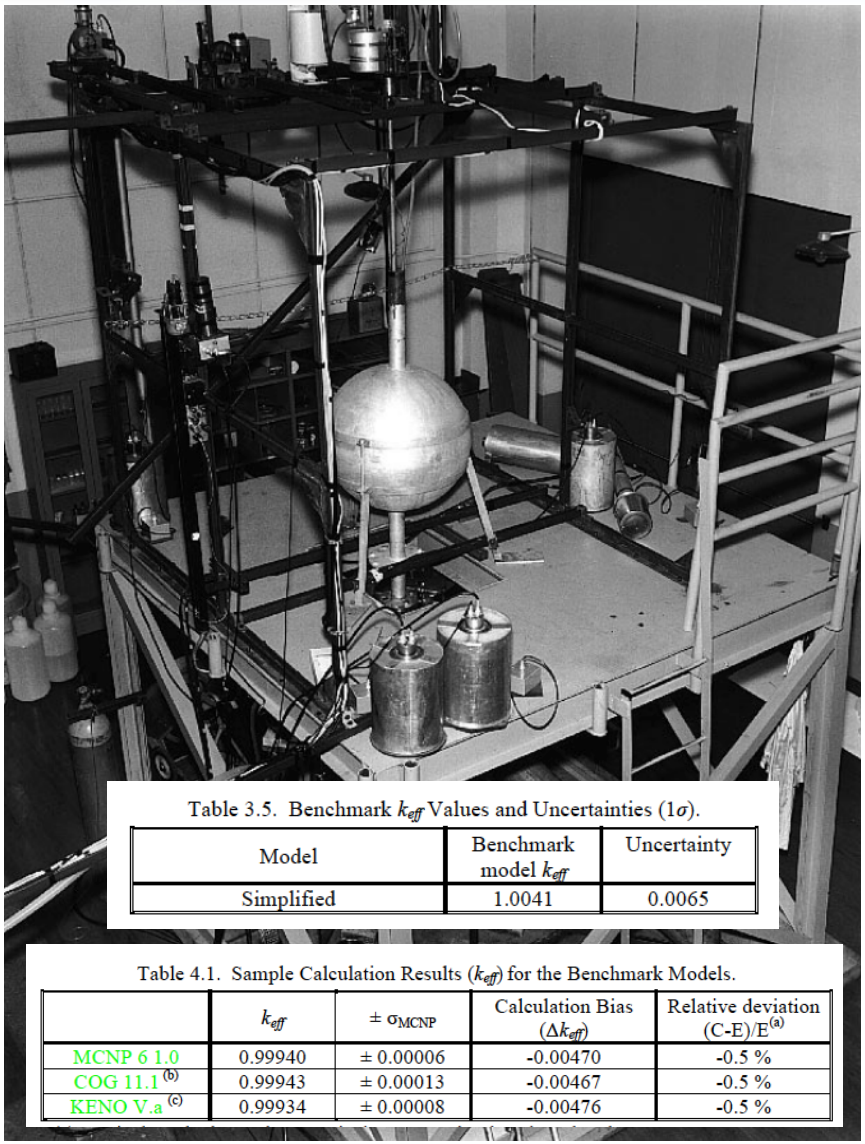

Table 3.5. Benchmark k_{eff} Values and Uncertainties (1σ).

Model	Benchmark model k_{eff}	Uncertainty
Simplified	1.0041	0.0065

Table 4.1. Sample Calculation Results (k_{eff}) for the Benchmark Models.

	k_{eff}	$\pm \sigma_{MCNP}$	Calculation Bias (Δk_{eff})	Relative deviation (C-E)/E[(a)]
MCNP 6 1.0	0.99940	± 0.00006	-0.00470	-0.5 %
COG 11.1 [(b)]	0.99943	± 0.00013	-0.00467	-0.5 %
KENO V.a [(c)]	0.99934	± 0.00008	-0.00476	-0.5 %

FY2015 Accomplishments – TRG

NEA/NSC/DOC(95)03/II
Volume II

HEU-MET-FAST-074

NEW

ORALLOY (93.2 ^{235}U) BARE METAL ANNULI AND DISKS

Evaluator

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Internal Reviewer
John D. Bess

Independent Reviewers

Michael F. Murphy
OECD/NEA Contractor

John T. Mihalczo
Oak Ridge National Laboratory

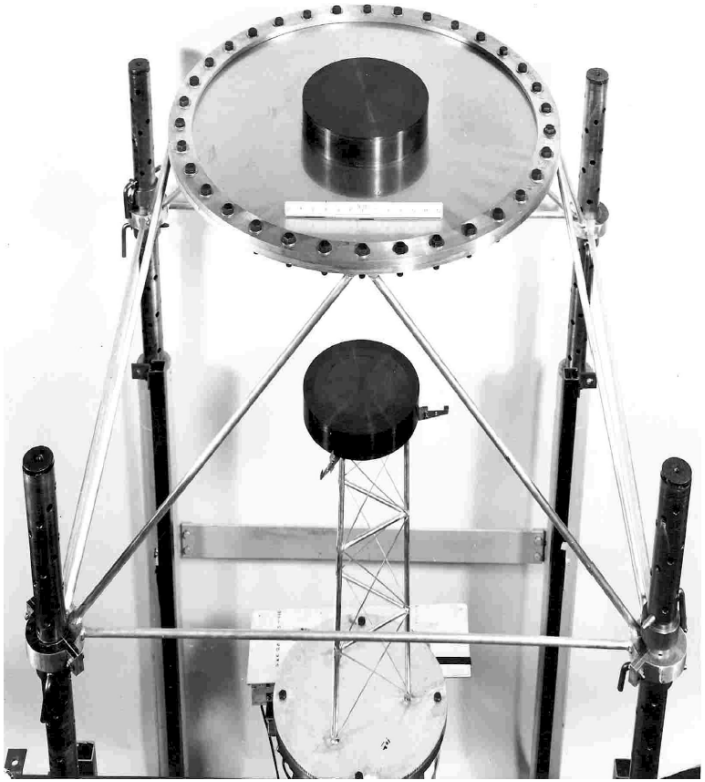

Table 4.1. Detailed Benchmark and Calculated Eigenvalues.

Case	Calculated			Benchmark Experiment			$\frac{C-E}{E}$%		
	k_{eff}	±	σ	k_{eff}	±	σ			
1	0.99640	±	0.00002	0.9988	±	0.0005	-0.24	±	0.05
2	0.99629	±	0.00002	0.9979	±	0.0005	-0.16	±	0.05
3	0.99471	±	0.00002	0.9970	±	0.0005	-0.23	±	0.05
4	0.99593	±	0.00002	0.9975	±	0.0005	-0.16	±	0.05

Results were calculated using MCNP6.1 with the ENDF/B-VII.1

FY2015 Accomplishments – TRG

NEA/NSC/DOC(95)03/II
Volume II

HEU-MET-FAST-077

NEW

EXPERIMENTS WITH HEU (93.14 wt.%) METAL ANNULI WITH INTERNAL GRAPHITE CYLINDER

Evaluator

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Chinese Academy of Engineering Physics

Internal Reviewers
John D. Bess
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Independent Reviewer

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John T. Mihalczo
Oak Ridge National Laboratory

中国工程物理研究院 CHINA ACADEMY OF ENGINEERING PHYSICS · INL Idaho National Laboratory · NEA · OAK RIDGE National Laboratory

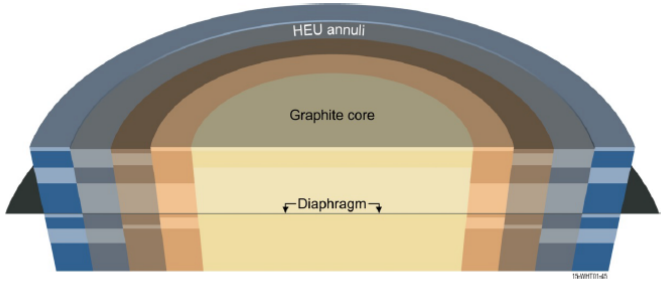

Figure 2. 3-D Figure for Core Configuration of Case 2.

Table 47. Comparison of Detailed Benchmark Model Experimental and Calculated Eigenvalues (Case 1).

Analysis Code	Neutron Cross Section Library	Calculated k_{eff} ± σ	Benchmark Experiment k_{eff} ± σ	$\frac{C-E}{E}$ %
MCNP6-1.0	ENDF/B-VII.1	0.99723 ± 0.00004	0.9981 ± 0.0006	-0.08 ± 0.06
	ENDF/B-VII.0	0.99735 ± 0.00004		-0.07 ± 0.06
	JEFF-3.1[(a)]	0.99408 ± 0.00004		-0.40 ± 0.06
	JENDL-3.3[(a)]	1.00077 ± 0.00004		0.27 ± 0.06

(a) Results provided by John D. Bess from Idaho National Laboratory.

Table 48. Comparison of Detailed Benchmark Model Experimental and Calculated Eigenvalues (Case 2).

Analysis Code	Neutron Cross Section Library	Calculated k_{eff} ± σ	Benchmark Experiment k_{eff} ± σ	$\frac{C-E}{E}$ %
MCNP6-1.0	ENDF/B-VII.1	0.99628 ± 0.00004	0.9971 ± 0.0006	-0.08 ± 0.06
	ENDF/B-VII.0	0.99640 ± 0.00004		-0.07 ± 0.06
	JEFF-3.1[(a)]	0.99312 ± 0.00004		-0.40 ± 0.06
	JENDL-3.3[(a)]	1.00005 ± 0.00004		0.29 ± 0.06

(a) Results provided by John D. Bess from Idaho National Laboratory.

Results were calculated using MCNP6-1.0

FY2015 Accomplishments – TRG

NEA/NSC/DOC(95)03/IV
Volume IV

LEU-COMP-THERM-067

NEW

CRITICAL LOADING CONFIGURATIONS OF THE IPEN/MB-01 REACTOR COMPOSED OF FUEL AND MOLYBDENUM RODS

Evaluators

Adimir dos Santos, Graciete Simões de Andrade e Silva, Leda Cristina Cabelo Bernardes Fanaro, Mitsuo Yamaguchi, Luis Felipe Liambos Mura, Rinaldo Fuga, and Rogério Jerez
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Stefano Sgarra
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Independent Reviewers

Andrew Hummel
John D. Bess
Idaho National Laboratory

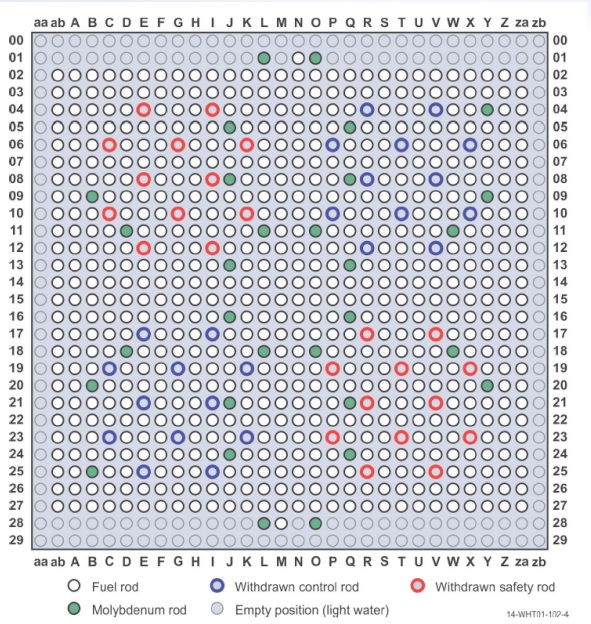


Figure 13. Experimental Core Configuration for Case 1.

Table 24. Final Values of k_{eff} and the Respective Uncertainties.

Case	N° Molybdenum Rods	k_{eff}	Temperature
1	30	1.0005 ± 0.0005	20.00 °C
2	28	1.0004 ± 0.0005	20.00 °C
3	24	1.0004 ± 0.0005	20.00 °C
4	20	1.0005 ± 0.0005	20.00 °C

Table 25. Sample Calculation Results .

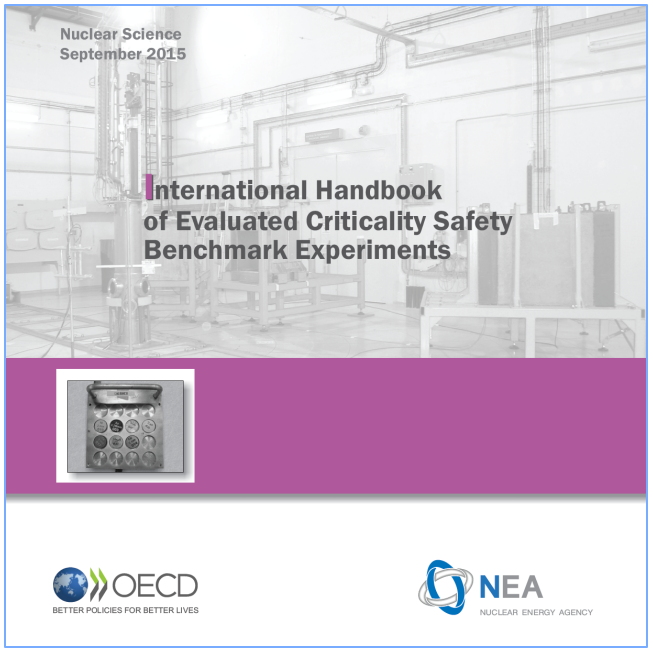
Code (Cross Section Set) → Case Number ↓	MCNP5 (Continuous Energy ENDF/B-VII.0)	Benchmark Value $k_{eff} \pm \sigma$	(C-E)/E %
1	1.00086 ± 0.00004	1.0005 ± 0.0005	0.036 ± 0.048
2	1.00068 ± 0.00004	1.0004 ± 0.0005	0.028 ± 0.048
3	1.00082 ± 0.00004	1.0004 ± 0.0005	0.042 ± 0.048
4	1.00094 ± 0.00004	1.0005 ± 0.0005	0.044 ± 0.048

FY2015 Accomplishments – Revisions & IRPhEP

SESSION 2:	DISCUSSION OF MINOR REVISIONS AND APPROVED IRPhEP EVALUATIONS	
HEU-SOL-THERM-020	Unreflected Cylinders of Uranyl-Fluoride Solutions in Heavy Water (Revision to Level Indicator Pipe Diameter)	John Bess
LEU-COMP-THERM-039	Incomplete Arrays of Water-Reflected 4.738-wt.%-Enriched Uranium Dioxide Fuel-Rod Arrays (Revision to Figure and APOLLO-MORET Calculations)	Nicolas LeClaire
HEU-MET-FAST-099 (ORCEF-SPACE-EXP-001)	Fast Neutron Spectrum Potassium Worth for Space Power Reactor Design Validation	John Bess
SESSION 3:	**DISCUSSION OF EVALUATIONS THAT HAVE BEEN REVISED TO INCLUDE ADDITIONAL DATA**	
HEU-COMP-FAST-004 (SCCA-SPACE-EXP-003)	Critical Configuration for Beryllium-Reflected Assemblies of U(93.15)O_2 Fuel Rods (1.506-cm Pitch and 7-Tube Clusters) (Revision to Include Two New Critical Configurations)	Margaret Marshall
SESSION 10:	**DISCUSSION OF MINOR REVISIONS AND APPROVED IRPhEP EVALUATIONS (Continued)**	
IEU-MET-FAST-020	The FR0 Series 1: Copper-Reflected "Cylindrical" Uranium (20 % 235U) Metal (Revision to Include Released Data)	Dennis Mennerdahl
IEU-MET-FAST-022	The FR0 Experiments with Diluted 20%-Enriched "Cylindrical" Uranium Metal Reflected by Copper (Revision to Include Released Data)	Dennis Mennerdahl
HEU-MET-FAST-083	Complex Geometry Bare Oralloy (93.15 ^{235}U) Metal Annuli Experiments	Quinton Beaulieu

Deferred to 2017

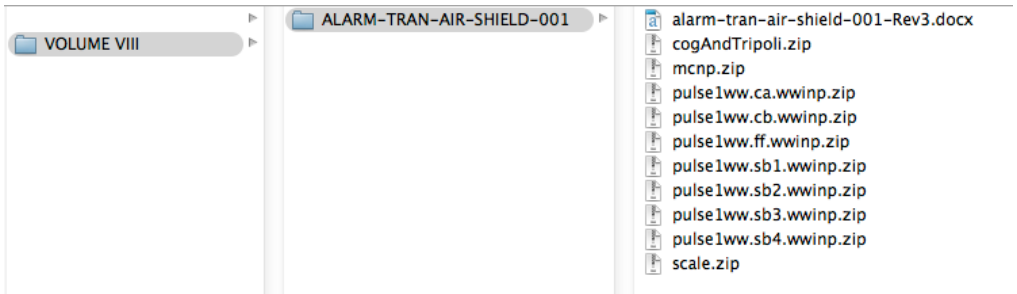
FY2016 Accomplishments



- OECD NEA provided 100 DVDs to LLNL for NCSP distribution
- 63 DVDs received and mailed out to registered NCSP users in January
- DVD size limitations are becoming a problem. 2016 solution = 2 DVDs
- DVD2 contains Volumes VIII and IX

IER161

IER126



FY2016 Work in Progress

The 2016 ICSBEP meeting will be convened jointly with IRPhEP the week of **April 18-22**, 2016, at OECD Nuclear Energy Agency (NEA) Headquarters in their new location at 46 Quai Alphonse Le Gallo, Boulogne-Billancourt, Paris. NCSP evaluations in preparation include:

- IER126, Silene CAAS Benchmark with Pb and CH_2/Cd Reflectors (T. Miller)
- IER161, BeRP/W (J. Hutchinson)
- IER285, 7uPCX with Ti Rods (G. Harms)
- Jezebel, Rev. 4 (J. Favorite)

The NCSP Manager has extended an invitation to NEA to host the ICSBEP/IRPhEP meeting in Washington, DC, the week of **October 31 - November 4**, 2017, which is the week before the ANS Winter Meeting.

Issues – Godiva IV

- No schedule for completion
- Need for revision identified in HEU-MET-FAST-086 in the disclaimer
- Additional data from DAF is available but not included in the evaluation
- Revision support IER-147, 148, 175, 268, etc.

NEA/NSC/DOC/(95)03/II
Volume II

HEU-MET-FAST-086

GODIVA-IV DELAYED-CRITICAL EXPERIMENTS AND DESCRIPTION OF AN ASSOCIATED PROMPT-BURST EXPERIMENT

DISCLAIMER:

When the Godiva IV critical assembly was refueled in 2012, additional details relevant to this benchmark became apparent. There are two revisions necessary for this evaluation to be correct:

First, the original drawing of the spindle was obsolete, which had a smaller glory hole than what is currently used in the assembly. The effect of the larger glory hole on system reactivity is negative due to the increased neutron leakage.

Second, there is a shim plate located under the safety block that alters the assumed height (and thus density) of the safety block. The presence of the shim has an important impact on the system. The density in the high importance region is currently underestimated and any neutron reflection from the shim piece is not accounted for. The corresponding correction of adding the shim and increasing the density of the safety block would have a positive effect on system reactivity.

The current evaluation is still available for use until the revised evaluation becomes available.

Additional information is provided below regarding the necessary revisions:

Spindle

Drawing 128Y1719431, "Godiva Core Top Subassy Spindle, Mod 11B," shows a glory hole with a ¼" (0.635 cm) inner diameter. Drawing 128Y1719515, "Godiva Core Subassy Spindle, Mod 0," is consistent with the current core configuration of Godiva IV. It shows a glory hole with an inner diameter of 9/16" (0.563", 1.42875 cm) instead. This diameter accommodates the current source holder and sample holder used for experiments on Godiva. Figure 1 shows a photograph of the current spindle with one inner fuel piece attached to it. Figures 2 and 3 show the pictorial and elevation views, respectively, of the two spindle designs.

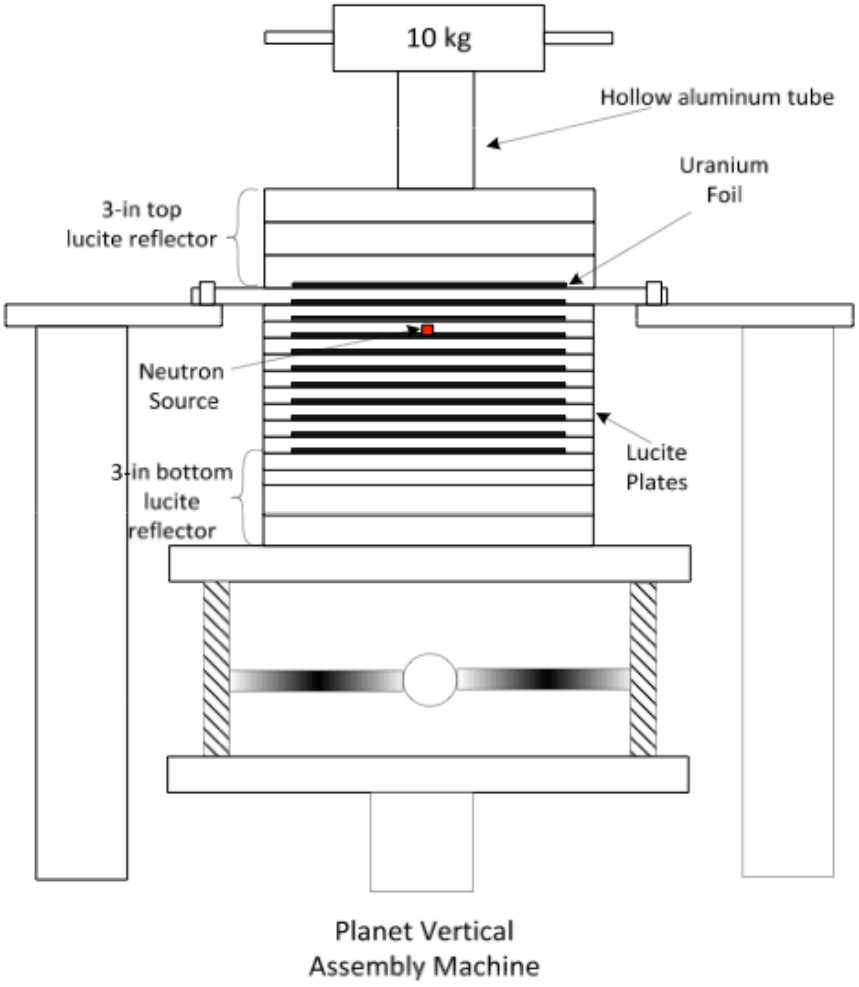
Figure 1: Photo of current Godiva IV spindle, ca. 2005.

Revision: 1
Date: September 30, 2014

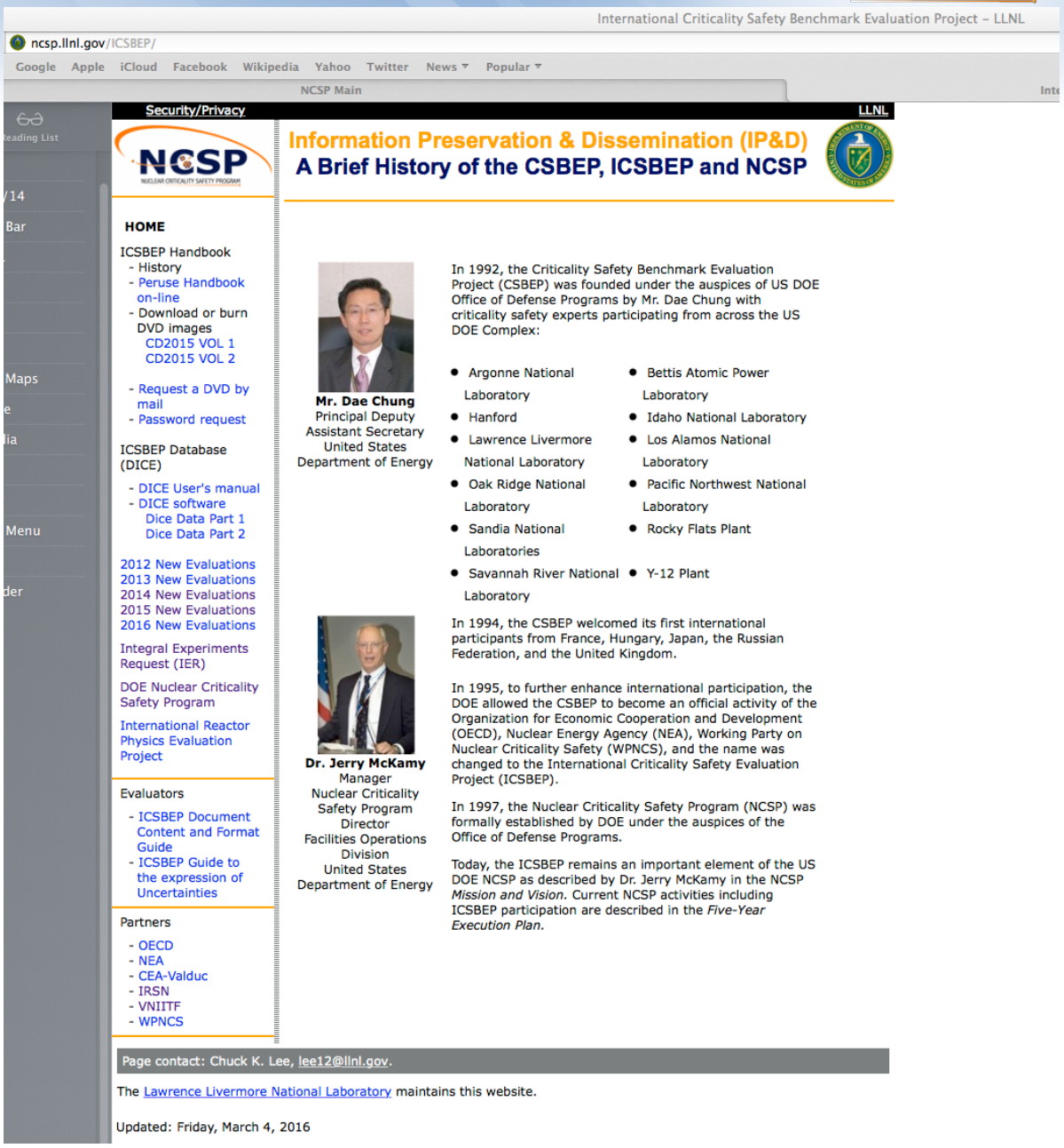
Page 1 of 4

Issues – Class Foils in Lucite

- No schedule for completion
- Lucite plates documented in LA-UR-13-20325
- HEU-MET-THERM-032 is a very similar experiment with polyethylene instead of lucite
- HEU-MET-THERM-032 was completed by Rene Sanchez and 4 collaborators from the Jozef Stefan Institute
- Volunteers are available to assist in completion



Questions?


International Criticality Safety Benchmark Evaluation Project – LLNL
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- Password request
ICSBEP Database (DICE)
- DICE User's manual
- DICE software
Dice Data Part 1
Dice Data Part 2
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2014 New Evaluations
2015 New Evaluations
2016 New Evaluations
Integral Experiments Request (IER)
DOE Nuclear Criticality Safety Program
International Reactor Physics Evaluation Project
Evaluators
- ICSBEP Document Content and Format Guide
- ICSBEP Guide to the expression of Uncertainties
Partners
- OECD
- NEA
- CEA-Valduc
- IRSN
- VNIITF
- WPNCS
Information Preservation & Dissemination (IP&D)
A Brief History of the CSBEP, ICSBEP and NCSP
Mr. Dae Chung
Principal Deputy Assistant Secretary
United States Department of Energy
In 1992, the Criticality Safety Benchmark Evaluation Project (CSBEP) was founded under the auspices of US DOE Office of Defense Programs by Mr. Dae Chung with criticality safety experts participating from across the US DOE Complex:
Argonne National Laboratory
Bettis Atomic Power Laboratory
Hanford
Idaho National Laboratory
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
Oak Ridge National Laboratory
Pacific Northwest National Laboratory
Sandia National Laboratories
Rocky Flats Plant
Savannah River National Laboratory
Y-12 Plant
Dr. Jerry McKamy
Manager
Nuclear Criticality Safety Program
Director
Facilities Operations Division
United States Department of Energy
In 1994, the CSBEP welcomed its first international participants from France, Hungary, Japan, the Russian Federation, and the United Kingdom.
In 1995, to further enhance international participation, the DOE allowed the CSBEP to become an official activity of the Organization for Economic Cooperation and Development (OECD), Nuclear Energy Agency (NEA), Working Party on Nuclear Criticality Safety (WPNCS), and the name was changed to the International Criticality Safety Evaluation Project (ICSBEP).
In 1997, the Nuclear Criticality Safety Program (NCSP) was formally established by DOE under the auspices of the Office of Defense Programs.
Today, the ICSBEP remains an important element of the US DOE NCSP as described by Dr. Jerry McKamy in the NCSP Mission and Vision. Current NCSP activities including ICSBEP participation are described in the Five-Year Execution Plan.
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The Lawrence Livermore National Laboratory maintains this website.
Updated: Friday, March 4, 2016